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(54) Subject of Invention

Manufacturing Method of Optical Fiber

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DETAILED DESCRIPTION

1. Subject of Invention

Manufacturing method of optical fiber

2. Scope of the Patent Claim

A manufacturing method of optical fiber having the following characteristics: In the manufacturing of optical fiber possessing clad layer of quartz,

immediately before the fiber spinning (drawing), the synthetic quartz layer (2) is deposited onto the surface of the optical fiber preform; under the condition shielded from the air, it is delivered to the heating furnace for spinning (drawing) and heated; and while the synthetic quartz layer (2) is being consolidated to glass, the spinning (fiber drawing) is performed.

3. Detailed Explanation of the Invention

[Abstract]

Immediately before fiber spinning (drawing), onto the surface of the optical fiber preform, by providing a glassified (consolidated glass) synthetic quartz layer and then performing the spinning, formation of scratches are prevented to enhance the reliability of the strength of the optical fiber.

[Industrial Application Field]

The present invention is related to an improvement on the manufacturing method of optical fiber.

In the quartz system optical fiber equipped with a clad of smaller refractive index to the outer circumference of the core of larger refractive index, to the axial center portion, the core layer 1A of (SiO_2-GeO_2-P_2O_5) was provided and to the outer

circumference, the clad layer 1B of SiO_2 was provided (cf. Fig 2). For example, an optical fiber preform of outside diameter 15 mm is delivered to a spinning (fiber drawing) furnace vertically and heat-melted to a spinning conical shape; and from the tip-end, it is made the desired outside diameter (for example, 125 um) to manufacture the fiber line by pulling.

During the spinning (fiber drawing), if scratches are present in the optical fiber, its strength cannot be compensated even by applying a coating afterward; thus the strength would be degraded.

Therefore, an optical fiber manufacturing method in that the occurrence of scratched during the fiber drawing would be small is being strongly demanded.

[Conventional Technology]

The optical fiber preform manufactured by the chemical vapor phase deposition method is generally that bubbles, defective holes, etc. would be scattered on the surface. And during the manufacturing of the optical fiber preform, the clad layer (the layer for the clad) of the outside layer would become high temperature; thus dusts, etc. in the air would be easily adsorbed onto the surface.

The defects formed on the surface of the optical fiber preform and the dusts, etc. are the major cause of scratch formation during the spinning (fiber drawing).

Therefore, hitherto, as a process prior to the spinning (fiber drawing) of the optical fiber, a surface treatment of the optical fiber preform is inserted.

For the surface treatment so far, 2 methods are available. In one of the methods, the optical fiber preform is soaked in a hydrofluoric acid aqueous solution for 5 minutes to 10 minutes to carry out etching to remove the preform surface layer by, for example, 5 um to 10 um of thickness.

The other method is a flame fire polishing method in that while the optical preform is being rotated, the flame of an oxyhydrogen flame is blown against the preform to heat at about 2000°C to melt and blow away the preform surface layer by, for example, 5 um to 10 um of thickness.

[The Problematic Points to be Solved by the Invention]

However, by the aforementioned conventional two methods, the deeper defects (most of the defects are more than 10 um in depth) cannot be removed completely; thus there has been problem that the scratches of the optical fiber after the spinning (drawing to fiber) cannot be reduced.

And, after the surface treatment process, the dusts in the air would be adhered; and these dusts would diffused inside the quartz surface layer to become defects as a result of the high temperature heating during the fiber drawing.

[The Means Used to Solve the Problem]

The present invention, for solving the aforementioned conventional problematic point, is as follows. In the manufacturing of an optical fiber possessing a clad layer of quartz, immediately before the fiber spinning (drawing), the synthetic quartz layer (2) is deposited onto the surface of the optical fiber preform by heating with a (O_2-H_2-$SiCl_4$) gas burner to complete the optical fiber preform 11, and under the condition the optical preform 11 is shielded from the air, for example, under the condition shielded by a nitrogen gas atmosphere, it is delivered to a heating furnace for spinning (drawing) and heated; while the synthetic quartz layer (2) is being consolidated to glass, the spinning (fiber drawing) is performed.

[Function]

According to the means (method) of the aforementioned present invention, the optical fiber preform 1 would be coated with a synthetic quartz layer of newly glassified (deposited layer consolidated to glass) to become the optical fiber preform 11; thus the surface defects, etc. of the optical fiber preform 11 would be closed.

And, it is shielded from the air containing many dusts by delivering nitrogen into the atmosphere; and since the spinning (fiber drawing) is performed under this condition, there would be no worry of dusts adhesion onto the optical fiber preform 11.

As described above, since there would be no defect, dust, etc. on the surface of the optical fiber preform 11 covered by the synthetic quartz layer 2, there would be no worry that scratches would occur to the optical fiber 3 to be obtained; thus the strength of the optical fiber would be stable and reliability would be enhanced.

[Implementation Example]

The present invention is concretely described based on an implementation example shown in the figures below.

Fig 1 is the construction diagram of an implementation example of the present invention. Fig 2 is the cross section of the optical fiber preform deposited with the synthetic quartz layer.

The constitutions in Fig 1 and Fig 2 are as follows: the optical fiber preform 1, in that to the outer circumference of the core layer 1A of (SiO_2-GeO_2-P_2O_5) of the axial center portion (to become the core), the clad layer 1B of SiO2 (to become the clad) is formed, is delivered vertically into the chamber 4 mounted with the burner 5 while it is being rotated.

The optical fiber preform 1 is heated by the burner 5 spraying the (O_2-H_2-$SiCl_4$) gas and the SiO_2 synthesized would adhered onto the surface. As shown in Fig 2, for example, a thickness of 100 um synthetic quartz layer 2 would be deposited to become the optical fiber preform 11.

The Cl_2 gas generated as a result of the chemical reaction is suction-exhausted from the exhaust opening 4a.

Directly beneath the chamber 4, the heating container 8 for fiber drawing (the container of the fiber drawing heating furnace) is arranged. The chamber 4 and the heating container 8 for fiber drawing are connected through the hollow connecting pipe 6 provided to the axial center portion. The connecting pipe 6 is a quartz pipe which is sufficient large enough inside to have the optical fiber preform passing through the hollow portion and provided with the gas spraying rings 7 equipped with air curtain function at the connecting portions with the chamber 4 and the fiber drawing container 8. From the gas spraying ring 7, nitrogen gas is sprayed into the connecting tube 6 to prevent the invasion of the gas inside the chamber into the connecting tube 6 and the heating container 8 for fiber drawing and simultaneously filling the inside of the connecting tube 6 and the drawing heating container 8 for fiber drawing with a clean nitrogen gas to shield the optical fiber preform 11 from the air atmosphere.

In the axial center portion of the heating container 8 for fiber drawing, the heater 9 such as a cylindrical shape carbon heater possessing slits in zigzag (shape) is arranged; it is constructed that the optical fiber preform 11 would descend at the desired speed through the hollow portion of the heater 9.

As described above, in the chamber 4, the optical fiber preform 11 deposited with the synthetic quartz layer 2 is delivered vertically into the fiber drawing heating furnace; by heating of the heater 9, the deposited layer would be consolidated to become synthetic quartz glass to completely cover the layer 1B for the clad which were scattered with surface defects.

The surface of the synthetic quartz layer 2 synthesized and consolidated to glass as described above would be a homogeneous constitution and there would be no __ (2 characters illegible), etc. defects. And, following the heating by the burner 5, since it is shielded from the air atmosphere (which contain dusts, etc.), no dust would adhere onto the surface.

After the synthetic quartz layer 2 (consolidated to glass) is formed on the surface, the optical fiber preform 11 is melted and the tip-end would become a spinning conical shape; then the optical fiber 3 would be spun.

As described above, the defects, dusts, etc. scattered on the surface of clad layer 1B of the optical fiber preform 1 would be covered by the synthetic quartz layer 2. Therefore, there would be no worry that scratches, etc. would occur to the optical fiber obtained by spinning (fiber drawing) the optical fiber preform 11.

Further, to illustrate this in a concrete example, to the surface of a preform which is 15 mm in outside diameter and 700 mm in length, 100 um thickness synthetic quartz were deposited and then 5 pieces of optical fibers of about 8 km with outside diameter 125 um were prepared. These optical fibers were performed for screening (test) with elongation percentage 1% for 5 seconds. The results were that among the 5 lots, one location was recognized in one lot.

By contrast, in the conventional treatment method, all of the 5 lots were recognized for breakage in more than one location.

[Effect of the Invention]

As described above, the manufacturing method of the present invention is that the optical fiber preform with defects, dusts , etc. scattered on the surface is to be covered by a clean surface synthetic quartz layer immediately prior to the fiber spinning (drawing). There would be less worry that scratches would occur to the spun (drawn) optical fiber; thus the strength would be stabilized and the reliability would be enhanced, etc. Superior effect on practical application is achieved.

4. Brief Explanation of Figures

Fig 1 is the construction diagram of an implementation example of the present invention.

Fig 2 is the cross section of an optical fiber preform deposited with the synthetic quartz layer related to the present invention.

In the figures:

1, 11 are optical fiber preforms;

1A is the core layer (layer for the core);

1B is the clad layer (layer for the clad);

2 is the synthetic quartz layer;

3 is the optical fiber;

4 is the chamber;

5 is the burner;

6 is the connecting pipe;

7 is the gas spraying-out ring;

8 is the heating container for spinning (fiber drawing);

9 is the heater.

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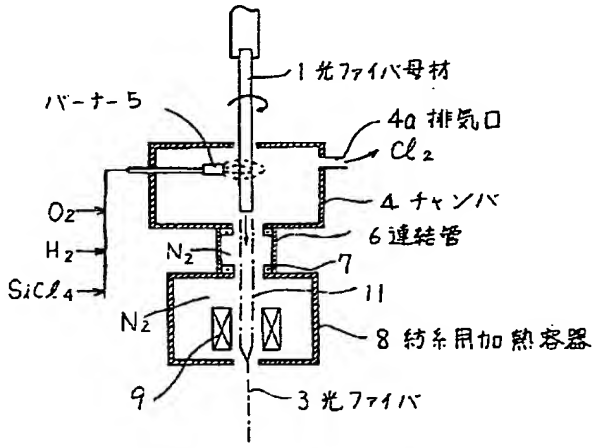
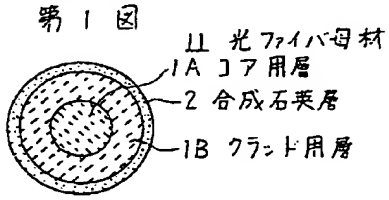
Figures not availble.

The last page of the Japanese patent containing the figures is missing in the copies I received for translation. [Translator's note]



本発明の実施例の構成図
第1図



本発明の光ファイバ母材の断面図
第2図